Space Weather Technical Forecast

Issued on Saturday, 15 April 2023 at 13:25 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-class flares (R1-R2 Minor-Moderate radio blackouts) throughout.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Moderate, with two low range M-class flares observed from AR3282 (Dki/βγδ) in the northeast quadrant, with a maximum of M1.5 at 14/2327UTC. In addition to the two flares, the region has also become more magnetically complex with a weak delta spot emerging. This group is one of 11 now observed on the visible disc. AR3281 is continuing to become more complex, but proper analysis is limited by the position close to the southeast limb. AR3279 is also showing some emerging complexity. AR3272 has faded somewhat, but AR3280 (Esi/βγδ) has become more complex and also contains a delta spot. The remaining regions are generally relatively simple and currently benign. A large CME was observed leaving the eastern limb on 14 April, accompanied by several smaller eruption, but modelling has suggested a clear miss at Earth. A further eruption from the southwest, from the region of AR3272 during 14 April will be analysed once further imagery becomes available.

Solar Wind / Geomagnetic Activity: The solar wind observed at L1 has generally been slow, below 400km/s, but showed a small but distinct increase later in the period. This increase was distinct as it correlated with an increase in the density from around average values to close to above average values, reaching 10ppcc at 15/1024UTC. This could be a weak high speed stream connection, with data continuing to be monitored. Total magnetic field strength, IMF, has been weak throughout, below 8nT, with the north-south component also varying weakly. The phi angle was resolutely positive (away from the Sun). Geomagnetic activity was Quiet to Unsettled throughout the period.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) as measured at GOES16, was at background levels. High energy electron flux (greater than 2MeV) as measured at GOES16 was at background levels. The associated 24-hour integrated electron fluence was well below the Active threshold on a steady trend, with 1.57e6 integrated pfu observed at 15/0000UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is forecast to be Quiet to Moderate. This is due to a number of magnetically and visually complex regions in the eastern hemisphere and a further complex region in the western hemisphere.

Solar Wind / Geomagnetic Activity: A CME which left the Sun on 12 April may glance the Earth on 16 April, but with low confidence. The Earth could be affected by two coronal holes during the period, but as these are at high latitudes in both the southern and northern hemispheres, any effect may just be a glance of the high speed stream. The most likely scenario is for the slow wind regime to persist during the four days. Geomagnetic activity is expected to remain Quiet to Unsettled, with a chance of Active or a slight chance of G1/Minor Storms due to the possible CME glance.

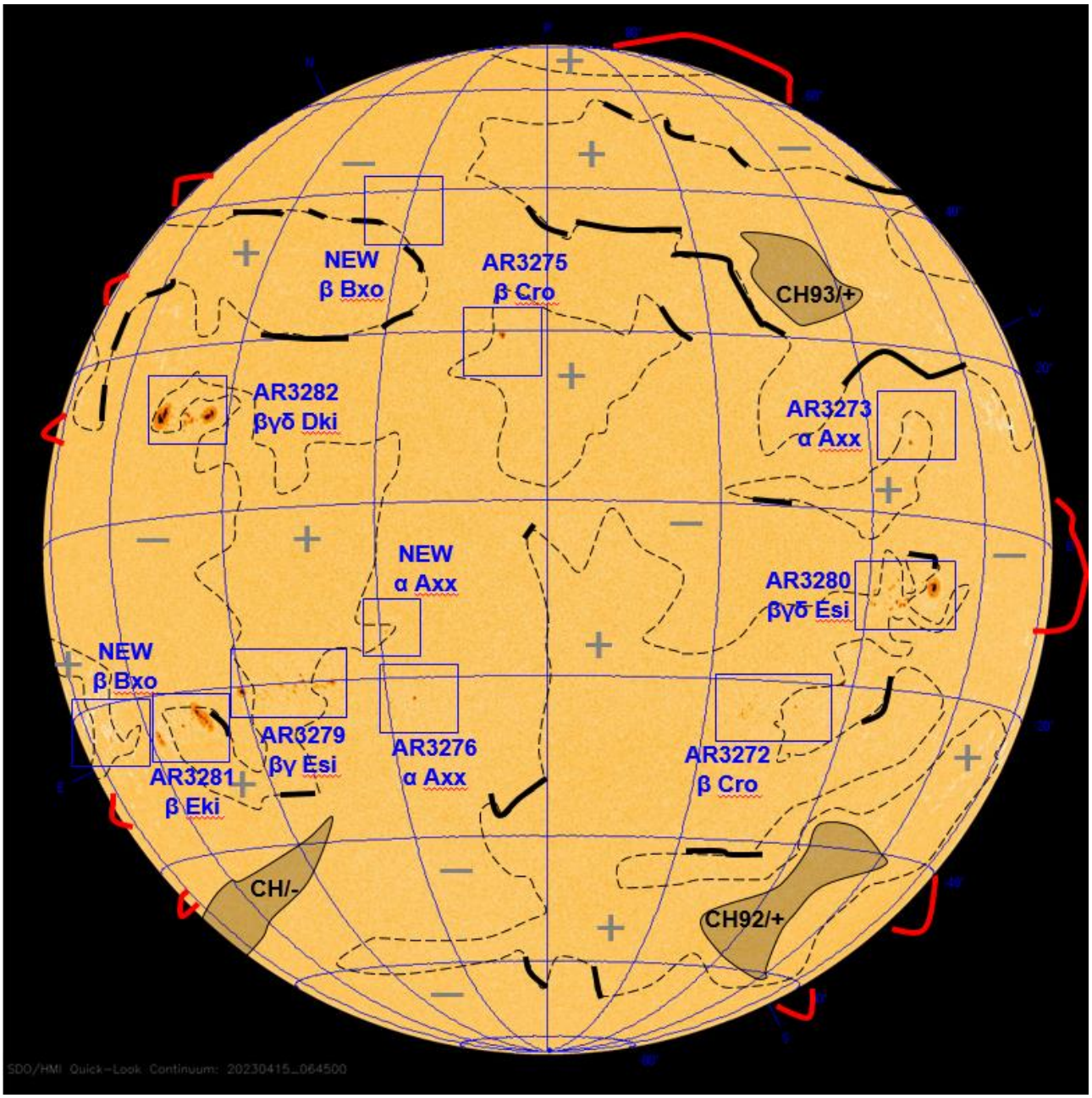
Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Met Office Space Weather Technical Forecast

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux is expected to persist at background levels, although there is a slight chance of a greater than S1 event as some of the more complex active regions transit towards the western solar hemisphere. High energy (greater than 2 MeV) electron flux is currently at background levels, and is considered most likely to remain so in the absence of any high confidence fast wind enhancements. The associated 24-hour integrated fluence is expected to remain below the Active threshold (1e8 integrated pfu).

Figure 1. Solar Analysis Valid 15/0800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Geomagnetic Storms:

A CME which left the southwest of the Sun on 12 April may glance the Earth on 16 April, but with a low confidence. Imagery from a further CME which left the southwest quadrant during 14 April has been slow to downlink, but will be analysed once sufficient data becomes available.
Two coronal holes are potentially rotating into positions where the high speed stream could connect with the Earth on 15 April. Coronal hole 92 in the southern hemisphere has reached a position where it could connect based on a speed of 400km/s. Coronal hole 93 in the northern hemisphere of the Sun may also connect on 15 April. Based on their positions the majority of the effects of either feature could pass to the south and north of the Earth respectively, but current observations at L1 suggest that at least some of the high speed stream could be reaching the Earth. As these are both new features on this rotation, persistence does not provide a useful guide to speeds, with STEREO A only showing modest enhancements to the solar wind.

Geomagnetic activity is forecast to be mainly Quiet to Unsettled, with a chance of Active and a very slight chance of G1/Minor Storms on 16 April due to the potential CME.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	5	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

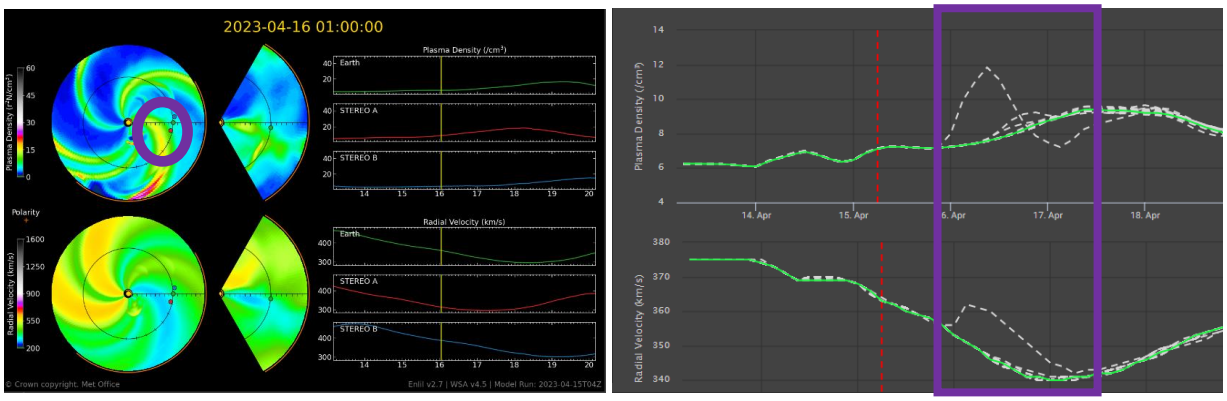
Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
12/0959	Partial	Filament	Southwest	550km/s	16/0300	Low confidence glancing effect.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Figure 2: Recent L1 solar wind data. The slight jump in both solar wind speed and density towards the end of the period could be indicative of a weak high speed stream connection.

Figure 3: MOSWOC Enlil forecast and MOSWOC Enlil ensemble, with the slight chance of a glancing CME indicated by the increase in the solar wind speed and density on 16 April. This is considered a low risk.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

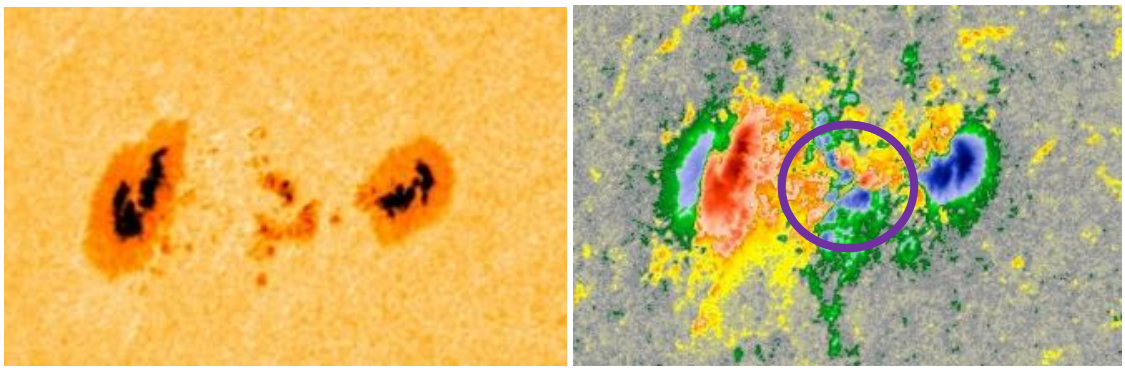
© Crown Copyright 2023. All Rights Reserved.

Radio Blackouts - X-Ray Flares:
Solar activity has been Moderate and is expected to be mainly Low or Moderate through the next four days.

AR3282 has the greatest influence on the forecast, developing rapidly, containing a delta spot and producing two low range M-class flares. The position in the eastern hemisphere suggests that any flares from this region could influence the Earth throughout the forecast period. AR3281 has also showing increasing complexity as it rotates onto the southeast limb. AR3280 carries the highest risk in the western hemisphere and is both magnetically and visually complex. The remaining regions are either simple, slowly evolving or fading.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	60	60
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 4: AR3282 (Dki/βγδ), the most rapidly growing and one of the most complex regions on the visible disc. A weak delta spot (circled) is visible in the centre of the region. Note that due to the position of the region ion the disc, the magnetic field to the left of the image is not displaying correctly



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Solar Radiation Storms - (High Energy Protons):
High energy proton flux (greater than 10MeV), as observed by GOES16, is most likely to remain at background levels through the period.

AR3280 carries the greatest risk of a proton event, with a high level of magnetic complexity and the existence of a delta spot as it rotates across the western hemisphere. A number of region in the east could produce some proton response from particularly energetic events, but this is considered low risk.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

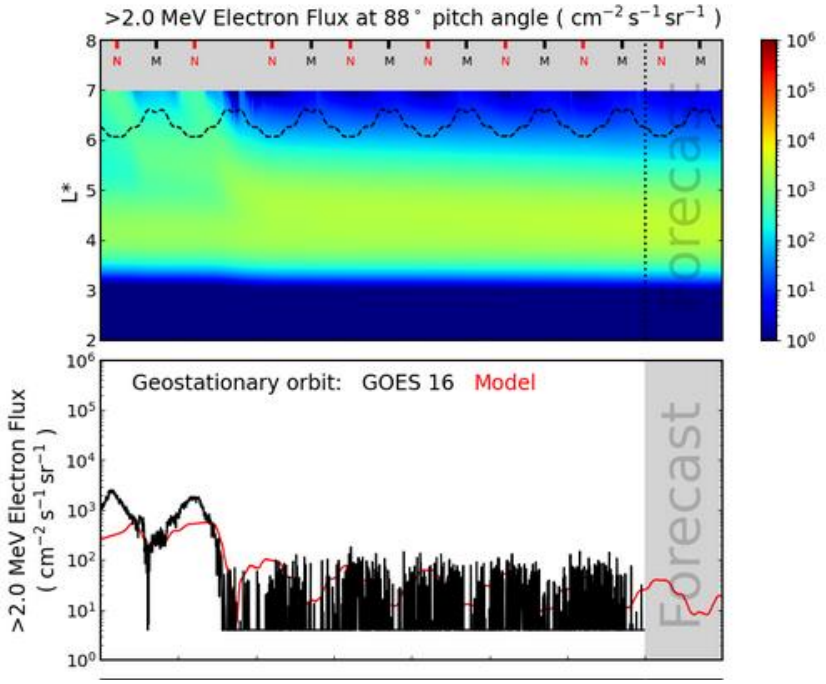
© Crown Copyright 2023. All Rights Reserved.

High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater then 2MeV) is at background levels and is likely to remain muted in a benign solar wind environment with no significant high speed stream effects expected. The British Antarctic Survey radiation Belt Model (BAS-RBM) is forecasting a similarly muted environment, with good verification from the last four days. Any inputs from CME effects may have a neutral effect in the short term, considering the balance between an increase in any geomagnetic activity and input of material into the radiation belts.

The associated electron fluence forecast is well below the Active (1e8 integrated pfu) threshold and is expected to remain so during the forecast period. MOSWOC REFM is forecasting a generally flat trend in fluence for the next four days, in contrast to that predicted by recurrence.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}\,sr^{-1}\,day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	5	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: BAS-RBM showing a trend for low levels of electrons at GEO. L* can be considered a proxy for distance from the Earth, with the black dashed line indicating a GEO orbit.


>2.0 MeV Electron Flux at 88° pitch angle (cm⁻² s⁻¹ sr⁻¹)
L*
Forecast
Geostationary orbit: GOES 16 Model
>2.0 MeV Electron Flux (cm⁻² s⁻¹ sr⁻¹)
Forecast

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.